Laboratory evaluation of insecticides and biopesticides against *Phenococcus solenopsis* and *Paracoccus marginatus* infesting cotton

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ABSTRACT

Acephate 700g a.i. /ha, Chlorpyriphos 500g a.i./ha, NSKE 5%, Neem oil (2.5 l /ha) + Nirma powder (0.1%), Nirma powder 0.1 %, *Verticillium lecanii* 5gm/lit (2 x 10^8 cfu/gm), *Beauveria bassiana* 5gm/lit (2 x 10^8 cfu/gm), *Metarhizium anisopliae* 5gm/lit (2 x 10^8 cfu/gm), Bacterial symbiont of entomopathogenic nematode (*Photorhabdus luminescens*) 20ml/lit (2 x 10^8 cfu/ml), Fish oil rosin soap 2ml / lit., Mealy Quit (New botanical formulation from CICR, Nagpur) 100ml/lit and Control (Water alone) were tested against nymphs and adults of *Phenacoccus solenopsis* and *Paracoccus marginatus* using cotton leaves (Bunny Bt) dipped in respective treatment solutions and air dried to remove excess water. Observations on insect mortality were recorded at 24 and 48h after treatment. Among different treatment tested on *P. solenopsis* nymphs, acephate recorded the highest mortality of 53.3 % at 48h after treatment. All the biopesticides tested were found to be on par in causing mortality of nymphs and adults. Chlorpyriphos and Mealy Quit were equally toxic causing 48.9% mortality at 48h after treatment. When tested against adults, the same trend of results was observed. When these treatments were tested against *P. marginatus* nymphs, again acephate ranked first with 55.56 % mortality at 48h after treatment. Chlorpyriphos, Mealy Quit and Fish Oil rosin soap were equally toxic causing 51.1 to 52.2 % mortality at 48h after treatment. Further studies are in progress to test the results under field condition.

Key words: Cotton Pests, mealy bug, insecticides, biopesticides, crop pest

INTRODUCTION

The use of Bt cotton in area crossing more 50 per cent along with novel insecticides changes the pest scenario in cotton shifting boll worm to secondary status. Simultaneously withdrawal of pesticides from cotton segment have also led to the out break of new pests like mealy bug and secondary out break of sucking pests like thrips. Wide spread incidence of mealy bug in almost all cotton growing regions in India was reported by Nagrare *et al*. (2009). Mealy bugs have become a serious threat to cotton cultivation in India. Symptoms of mealy bug infestation in cotton include stunting of plants and development of a bushy appearance. In affected plants, bolls are deformed, fewer and smaller in size. Therefore an experiment was conducted to evolve an effective and ecofriendly method for the management of two mealy bugs *viz*., *Phenococcus solenopsis* and *Paracoccus marginatus* infesting cotton under lab condition.

MATERIALS AND METHODS

Test insect

Mealy bug, *Phenococcus solenopsis* and *Paracoccus marginatus* were collected from naturally affected cotton plants at CICR, Regional station, Coimbatore and reared on sprouted potatoes and used for the study.

Bioassay

The bioassay was carried against two stages (nymph and adult) of two mealy bugs under laboratory condition. Cotton leaves (Bunny Bt) were collected from plants raised under green house condition and surface sterilized with alcohol. The following insecticides/biopesticides were tested. Acephate 700 g a.i./ha, chlorpyriphos 500g a.i./ha, NSKE 5%, Neem oil (2.5 l/ha) + Nirma powder (0.1%), Nirma powder (0.1%), *Verticillium lecanii* 5g/lit (2 x 10^8 cfu/gm), *Beauveria bassiana* 5g/lit (2 x 10^8 cfu/gm), *Metarhizium anisopliae* 5g/lit (2 x 10^8 cfu/gm), bacterial symbiont of entomopathogenic nematode 20 ml/ lit (2 x 10^8 cfu/ml)(*Photorhabdus luminescence*), Fish Oil Rosin soap 2 ml/lit, New botanical formulation from CICR, Nagpur (Mealy Quit) 100ml /lit and control (water) were used. Sterilized cotton leaves were dipped in respective treatment and air dried for 10 minutes. Leaves were kept on sterile moist filter paper in the Petri plates (9mm dia). Approximately 100 nymphs, adults were released and sealed with paraflim. Petriplates were stored at 25±1°C in

a BOD incubator. The date on insect mortality was recorded at 24 and 48 Hours after inoculation (HAI). To verify mortality or survival, a fine hair brush was used to touch the body of the insect, in order to induce or detect movement. Individuals were considered dead based on the absence of leg movement after stimulus or colour change. In case of biopesticides treated insects, cadavers were surface sterilized in absolute alcohol and placed on SDYA medium for growth of the fungi. Cadavers from *P. luminescens* treatments were surface sterilized dissected and streaked on to (NBTA) Nutrient Agar supplemented with 0.025 % Bromothymol Blue and Tri phenyl Tetrazolium Chloride 0.04 g /l(TTC). Each treatment was replicated thrice. Percent insect mortality was transformed to Arc sine transformation and statistically analyzed.

RESULTS

The screening of pesticides and biopesticides against nymphs and adults of *Phenococcus solenopsis* was presented in Table 1. Among two stages tested, nymphs were found to be more susceptible than adults. No mortality of nymphs and adults were recorded in control.When tested against nymphs, acephate recorded a maximum of 40.00 % and 53.33 % mortality at 24 and 48h after treatment respectively and it ranked first. At 48h after treatment chlorpyriphos and mealy quit ranked second with 48.89 % mortality and were found to be on par. When tested against adults, the same trend of results was observed. Acephate recorded a maximum of 64.44 % mortality at 48h after treatment. Chlorpyriphos and mealy quit recorded 60.00 % mortality and were at par.

Perusal of data on the effect of pesticides and biopesticides against *P. marginatus* revealed that the chemicals were found to be superior than biopesticides against both nymphs and adults at two exposure periods (Table 2). Here also nymphs were found to be more susceptible than adults. Acephate recorded maximum of 57.78 % mortality of adults at 48h after treatment Chlorpyriphos ranked second and recorded 55.56 % mortality against nymphs. Mealy quit, Neem oil + Nirma powder , Nirma powder alone, *Verticillium lecanii* recorded more than 50 % mortality against nymphs at 48 h after treatment. When tested against adults, Acephate ranked first with 55.56 % mortality. Chlorpyriphos , fish oil rosin soap and mealy quit were found to be at par. All biocontrol agents showed hyphal penetration in body of both nymph and adults and grow thick network of hyphae on insect cadavers.

DISCUSSION

Mealy bugs (Hemiptera: Pseudococcidae) are important pest of cultivated and ornamental crops world wide. For successful use of pesticides/biopesticides, information is not only needed on the biology and feeding activity of the control agents but also on the most susceptible stage of pest species (Cuthbertson *et al.*, 2003). Here the nymphs were found to be highly susceptible to both insecticides and biopesticides followed by adults. The presence of wax on the cuticle of adults might have prevented the entry of insecticide inside the insect body. This result corroborate with the findings of Larrry *et al.*, 2002 who reported that methyl bromide show the highest mortality against pink hibiscus mealy bug, *Macronellicoccus hirsutus* in the egg stage followed by instars and adults. Curkovic *et al.*, 2007 also reported the susceptibility of long mealy bug, *Pseudococcus longispinus* nymphs over

Table 1. Screening of pesticides and biopesticides against *Phenococcus solenopsis*

Treatments	Mortality (%)			
	Nymph		Adult	
	24 hours	48 hours	24 hours	48 hours
Acephate 700a.i /ha	40.00 (39.20)[a]	53.33 (46.92) [a]	37.78 (37.81) [a]	64.44 (53.41) [a]
Chlorpyriphos 500g a.i./ha	35.55 (36.59)[ab]	48.89 (44.36) [ab]	33.33 (35.20) [ab]	60.00 (50.81) [ab]
NSKE 5%	31.11 (33.69)[abc]	42.22 (40.52) [abc]	33.33 (35.20) [ab]	55.56 (48.25)[abc]
Neem oil (2.5 l /ha)+Nirma powder (0.1%)	30.00 (33.19)[abc]	46.67 (43.08) [ab]	33.33 (35.20) [ab]	57.78 (49.48)[abc]
Nirma powder (0.1 %)	30.00 (33.19) [abc]	40.00 (39.20) [bc]	28.89 (32.30) [ab]	53.33 (46.92)[bc]
Verticillium lecanii 5gm/lit (2 x 10^8 cfu/gm)	28.89 (32.48) [abc]	37.78 (37.81) [bc]	26.67 (30.97) [ab]	55.56 (48.25) [abc]
Beauveria bassiana 5gm/lit (2 x 10^8 cfu/gm)	25.56 (30.29) [bc]	35.56 (36.48) [bc]	26.67 (30.36) [ab]	48.89 (44.36) [c]
Metarhizium anisopliae 5gm/lit (2 x 10^8 cfu/gm)	24.44 (29.47) [c]	31.11 (33.87) [c]	26.67 (30.97) [ab]	48.86 (44.36) [c]
Bacterial symbionts of nematode 20ml/lit(2 x 10^8 cfu/ml)	32.33 (34.58) [abc]	40.00 (39.20) [abc]	22.22 (22.75) [b]	53.33 (46.92) [bc]
Fish oil rosin soap (2ml / lit).	32.22 (34.51) [abc]	42.22 (40.52) [abc]	33.33 (35.20) [ab]	57.78 (49.48) [abc]
New botanical formulation (100ml/lit).	33.33 (35.20) [abc]	48.89 (44.36) [ab]	33.33 (335.20) [ab]	60.00 (50.81) [ab]
Control (Water)	0.10 (1.81)[d]	0.10 (1.81)[d]	0.10 (1.81) [c]	0.10 (1.81) [d]
CD(0.01)	(8.63)	(10.80)	(12.21)	(8.76)

Figure in parantheses are sine transformed values.

Table 2. Screening of pesticides and biopesticides against *Paracoccus marginatus*

Treatment	Mortality (%)			
	Nymph		Adult	
	24 hours	48 hours	24 hours	48 hours
Acephate 700a.i /ha	36.67 (37.23)^{ab}	57.78 (49.53)^{a}	37.78 (37.91)^{a}	55.56 (45.65)^{a}
Chlorpyriphos 500g a.i./ha	38.89 (38.51)^{a}	55.56 (48.21)^{ab}	34.44 (35.90)^{ab}	52.22 (47.56)^{ab}
NSKE 5%	27.78 (31.68)^{bcd}	48.89 (44.35)^{abc}	28.89 (32.30)^{bcd}	44.45 (39.83)^{bcd}
Neem oil (2.5 l /ha)+Nirma powder (0.1%)	30.00 (33.19)^{abcd}	51.11 (45.65)^{abc}	28.89 (32.38)^{bcd}	50.00 (45.64)^{abc}
Nirma powder (0.1 %)	27.78 (31.68)^{bcd}	51.11 (45.65)^{abc}	28.89 (32.38)^{abcd}	46.67 (41.81)^{bcd}
Verticillium lecanii 5gm/lit (2 x 10^{8} cfu/gm)	26.67 (30.97)^{cd}	51.11 (45.65)^{abc}	26.67 (30.97)^{bcd}	42.22 (49.53)^{cd}
Beauveria bassiana 5gm/lit (2 x 10^{8} cfu/gm)	24.45 (29.58)^{dc}	44.45 (41.81)^{bc}	24.45 (29.58)^{cd}	42.22 (43.08)^{cd}
Metarhizium anisopliae 5gm/lit (2 x 10^{8} cfu/gm)	25.56 (30.29)^{cd}	44.44 (41.79)^{bc}	22.22 (28.08)^{d}	40.00 (44.35)^{d}
Bacterial symbionts of nematode 20ml/lit(2 x 10^{8} cfu/ml)	16.67 (24.03)^{c}	41.11(39.83)^{c}	24.45 (29.58)^{cd}	46.67 (48.21)^{bcd}
Fish oil rosin soap (2ml / lit).	32.22 (34.51)^{abcd}	46.67 (43.08)^{bc}	30.11 (33.07)^{abcd}	51.11 (41.79)^{ab}
New botanical formulation (100ml/lit).	34.44 (35.90)^{abc}	54.44 (47.56)^{ab}	31.11 (33.87)^{abc}	51.11 (41.79)^{ab}
Control (Water)	0.10 (1.81)^{f}	0.10 (1.81)^{d}	0.10 (1.81)^{e}	0.10 (1.8)1^{e}
CD(0.01)	(8.43)	(8.74)	(7.42)	(6.13)

*Figures in parenthesis are sine transformed valves.

adults. This may also be due to smaller size of nymphs and the presence of less amount of surface wax on nymphs than adults which makes them more susceptible to insecticides/biopesticides.

Monga *et al*., 2008 reported the imidecloprid showed less inhibitory effect on *Fusarium pallidoroseum* and *Vericillium lecanii* followed by thiodicarb and acephate. Vertilite (a commercial formulation of *V. lecanii*) in combination with acephate has showed significant control of mealy bug under field condition.

Exotic pests, especially those that are polyphagous with a wide host range, establish themselves easily in the introduced countries in the absence of their native, naturally occurring predators, parasitoids and pathogens. Moreover, pests such as the mealy bug establish and spread more easily than many other insect species since they, possess a waxy coating on the dorsal side that protects them from insecticides and natural mortality factors; have a high reproductive rate ; have the ability to hide in the soil , cracks and crevices of plants and have propensity to spread quickly through natural carriers such as plant products , wind , water , rain , birds , human beings and farm animals.

Pathogenicity of different strains of *Metarhizium anisopliae* var strains was tested on pink hibiscus mealy bug. Among three strains tested, *M.anisopliae* var a*cridum* strain Ma 1912 reduced egg hatching up to 60% and 100% mortality of instars was observed by 4 days after inoculation(Ujjan and Shahzad, 2007).

In this experiment, Nirma powder (detergent) was able to produce significant mortality of nymphs and adults of both mealy bugs. Insecticidal activity of two detergents SU 120 and Tecsa Fruta were evaluated against long tailed mealy bug, *Pseudococcus longispinus* under laboratory condition (Curkovic *et al.*, 2007). They suggested that both nymphs and adults were highly susceptible to the detergents tested at varying levels.The decreasing superficial tension caused by detergent solution may also have contributed to some amount of mortality of insects.

The biopesticides *viz, V.lecanii*, *M.anisopliae* and *B.bassiana* caused mortality of both nymphs and adults. In the present study, cuticular degradation was noticed which was followed by the development of fungi on the insect body. The cuticular degradation may be due to the secretion of hydrolic enzymes such as proteases, chitinases and lipases by *V. lecanii, M. anisopliae* and *B. bassiana*. They play an important role in the initiation of the infection process by entomopathogenic fungi. Chevan and Kadam (2009) recorded a maximum of 82.5% mortality of *M. hirsutus* nymphs (one day old) in formulation containing *V.lecanii* + glycerol 8% + Tween 80 1% and Arachnid 0.5%. This study clearly indicated the susceptibility of both nymph and adults of mealy bug to different insecticides and biopesticides. Further experiments are being carried out to evolve effective, ecofriendly management strategy for the management of mealy bug in cotton under field condition.

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